NEUTRON RADIOGRAPHY AND TOMOGRAPHY AT THE IBR-2 REACTOR: THE MAIN SCIENTIFIC DIRECTIONS

S.E. Kichanov[1], I. Yu. Zel[1], D. P. Kozlenko[1], B. A. Bakirov[1], B.A. Abdurakhimov[1] and I.A.Saprykina[1,2]

[1]*Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, Dubna, Russia*
[2]*Institute of Archaeology RAS, Moscow, Russia*

E-mail: ekich@nf.jinr.ru

Information about the internal structure of materials with a spatial resolution at the micron level can be obtained using neutron radiography due to the difference in the degree of attenuation of neutron beam intensity in materials with different chemical composition, density, and thickness of the components entering the material composition. Neutron radiography provides a two-dimensional projection of an object under study, while tomography is used to obtain a three-dimensional image, where a volumetric reconstruction of the internal structure of object studied is performed based on a set of radiographic projections obtained at different angular positions of the sample relative to the beam direction. The fundamental difference in nature of neutron interaction with matter compared to X-rays provides additional benefits to neutron methods, including sensitivity to light elements, a notable difference in contrast between isotopes, high penetration effect through metals or heavy elements. Nowadays, the detailed neutron structural studies of different types of objects in order to obtain the necessary data for the growth of knowledge on those objects for the purpose of improving existing models and scientific ideas about the nature, formation, and evolution is request. The three-dimension (3D) arrangement of the inner components, as well as the morphological parameters of structural elements of different objects, were studied using neutron tomography. It should be noted that the neutron tomography method provides the detailed spatial distribution of different elements inside a given volume with a relatively high spatial resolution. In the report, the neutron tomography experiments at the neutron radiography and tomography facility placed on beamline 14 of the IBR-2 high-flux pulsed reactor were provided. The main scientific directions and results obtained on this experimental station are reviewed.
Meteorites are quite rare representatives of extraterrestrial matter. And as expected, the scientific community is fully focused on the study of elemental and isotopic content, chemical and mineral composition, the search for metallic inclusions of the recently discovered meteorites. The determination of major and minor phases, their textural associations, dimensions, shapes, and spatial arrangement is important for understanding the petrography of meteorites. And only recently, it became possible to study the rather large fragment of the Kunya-Urgench meteorite using modern methods of neutron non-destructive testing. As a result, the internal structural organization, phase analysis, three-dimension (3D) volume data, as well as the results of the corresponding morphological calculations, of the large fragment of the Kunya-Urgench meteorite are reported.
Currently, coins are being intensely investigated by means of non-destructive physical methods, such as traditional techniques like metallography or X-ray diffraction. In this context, we should also mention the neutron radiography and neutron diffraction methods as the relative modern structural non-destructive experimental approach. We present neutron tomography and diffraction data supported X-ray fluorescence analysis, for the non-destructive identification of the copper alloy composition, and reconstruction of the initial view of original coins and their remain parts under from the patina layer.